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ABSTRACT

This study identifies the most common biological concepts presented in elementary science textbooks in Taiwan. The concepts focus on living things, animals, and plants in grades one through four. Three major areas of concern are: attributes of the three related concepts; development of the concepts focusing on content organization and their connections, repetition, and complexity; and pedagogical emphasis of the text. The commonly addressed attributes were found to be "habitat," "movement," "growth," "energy source," and "structure." Concepts are organized from high level to low level, and links among the concepts within a unit or across units are not adequately made. The application of concepts is neglected and inquiry-based experiments are lacking. Contains 16 references, 3 data tables, and 3 figures. (Author/DDR)

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Biological Concept Development in Elementary Science Textbooks in Taiwan

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Abstract

The purpose of the study is to examine how biological concepts are presented in elementary science textbooks in Taiwan. The concepts focus on living things, animals, and plants presented in grades one to four. Fifteen units of the elementary science textbooks (1994) used by all school districts in Taiwan have been chosen for consinderation. Three major areas of concern are: (1) attributes of the three related concepts, (2) development of the concepts focusing on content organization and their connections, repetition, and complexity, and (3) pedagogical emphasis of the text.

Results of the study indicate that the commonly addressed attributes are: "habitat", "movement", "growth", "energy source", and "structure". Textbooks organize concepts from a very high level concept (living things), to lower level concepts (animal and plants), and then to more specific concepts (e.g., fish and silkworms). Futhermore, links among the concepts within a unit or across units are not adequately made. The text presents science as a way of thinking, but neglects the application of concepts and lacks inquiry based experiments and students' prior knowledge.

Biological Concept Development in Elementary Science Textbooks in Taiwan.

Introduction

A growing body of research suggests that concept development is dependent on the content area (Carey, 1985; Driver & Easley, 1978). Achievement in science depends, to a greater extent, on specific knowledge and prior experience rather than general levels of cognitive structure (Driver & Easley, 1978).

Alternative conceptions have been found to be prevalent in students at various grade levels despite formal teaching in schools (Driver & Oldham, 1986; Shiao, 1995). Research has found that the concepts of living things, animals and plants held by the children in fourth grade in Taiwan were quite different from those of biologists (Shiao, 1995). Students' alternative conceptions and incoherent views of the three biological concepts reflect an inadequacy of the current science curriculum or instruction.

Thus it is important for researchers to study how textbooks develop their biological concepts as well as the concepts of other subject areas in science. This study provides significant information for curriculum designers and teachers about how to organize biological concepts in science textbooks

In Taiwan the textbooks play a very important role in science teaching and learning. Each elementary grade has the same science textbook and fixed class periods, which teachers have to follow exactly. The centralized curriculum in Taiwan has been changed since the Fall semester of 1996. Now first and second grades can choose their science textbook series from different publishers. However, there is little research in elementary science textbooks that provides knowledge for textbook design and improvement.

Purpose

The purpose of this study is to examine how biological concepts are presented in the elementary science textbooks from grades one to four in Taiwan. The study

focuses on three biological concepts: living things, animals, and plants. Three research questions are asked :

1 Which attributes of the concepts related to living things, animals, and plants are addressed in the elementary science textbooks from grades one to four in Taiwan?

2 How are these concepts presented in the elementary science textbooks?

3 What is the pedagogical emphasis of the elementary science textbooks?

Review of Related Literature

Researchers from different perspectives have attempted to figure out why children have problems to understand scientific concepts. This study focuses on the perspectives: how children learn concepts and concepts at different levels, and based on that how science concepts should be presented in textbooks. Research on concept learning and on science textbooks were reviewed.

Concept Learning

Research shows that concept learning through exemplars plays an important role in conceptual development, especially in younger children. Kossan (1981) found 7-year-olds learn more quickly under conditions that need close attention to specific examples than under conditions that need learning of a rule for classifying new examples. In contrast, 10-year-olds learn well under both conditions. Since children may have difficulty when seeing a totally new object, they must have some basis of comparison beyond a simple match or not. Siegler (1991) pointed out that children have to develop important features and relations to represent concepts. Representations of specific examples are a part of conceptual representation at all ages, but not all of conceptual representations at any age.

Many categories are hierarchical. Typically there are at least three levels; a general level (a superordinate level), a specific one (a subordinate level), and one of

middling generality (a basic level) (Rosch, et al., 1976). For example, "bird" is a basic-level category; "animal" is a superordinate one; and "robin" is subordinate one.

How do children acquire concepts at different levels of generality? The possible trend for concept development is that children first learn concepts at an intermediate level of generality and later learn more specific terms through differentiation and more general terms through hierarchic integration (Aglin, 1977). Basic-level categories play prominent roles in early conceptual development.

Abdullah and Lowell (1981) investigated the ability of elementary school students to generalize two science concepts, *insect* and *animal* , with and without instruction in the form of a mental set. It was found that the children in this study were more able to generalize the concept *insect* than the *animal* concept. Children, with age and instruction, are better able to master a less general concept, *insects* , easier than a more general one, *animal*. The study also showed that children were able to improve their ability to generalize a concept if instruction included a great number and variety of instances and noninstances of the concept.

Investigations reveal that children first learn category names for objects which are familiar and important to them in their daily lives and later learn labels for less familiar and less important objects (Aglin, 1977). It seems consistent with the finding that the frequency of occurrence is the determinant of the order of acquisition of category labels (Abdullah & Lowell, 1981).

Shiao (1995) has investigated three biological concepts, *living things*, *animals*, and *plants* held by 24 fourth graders in Taiwan. The study found that most of the fourth graders' concepts were different from those of biologists. The concept of *living things* is much more difficult than the *animal* or *plant* concept. The alternative concepts of living things, animals, and plants were pervasive. Animals are viewed as prototypes of living things. Insects are not animals and are an equal group of animals,

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not a subgroup of animals. In this study several students did not even consider plants as living things.

Research on Science Textbooks

A review of textbook analyses relevant to this study was conducted. It focused on concept development and pedagogical emphasis of elementary science textbooks.

Tull (1991) analyzed the development of botanical concepts presented in the elementary textbook series Silver Burdett Science, 1985. The concept maps for each unit were used to evaluate the development of concepts with respect to connections between concepts, complexity of the text, and repetition of topics. Connections between concepts were generally made in the text. The concept maps of the text in upper grade revealed a high degree of complexity. The hierarchical levels of concepts varied from two to ten. Unnecessary repetition of topics were found in the elementary school texts.

In Tull's study children's botanical concepts were also compared with those presented in the text. It was found that the children had a poor understanding of many of the botanical concepts found in the text and lacked scientific classification schemes. The concepts were related to reproduction and differences between living and nonliving things and between plants and animals.

The pedagogical emphasis on the text indicated that the text presented science as a body of facts rather than as a process, neglected human use of plants and social issues, and lacked inquiry based experiments.

Staver and Bay (1989) examined the development of concepts in eleven science texts for K-3 through concept maps. They found that concepts were developed differently in deferent texts. The concepts in some texts were more complex than others. The text reasoning demands were often above the level of children's cognitive

development. In some texts, concept maps indicated that concepts are not connected, but in most texts concepts were well defined.

In terms of the recommendations of Project Synthesis the pedagogical emphasis in 11 elementary science textbook series were analyzed as well. Staver and Bay (1989) found that the texts placed an emphasis on the academic concept development and provided little coverage on careers on science or the relationship of science to society. Some texts covered the personal needs goal in some topics. Also, the text put little emphasis on activities and experiments, especially for inquiry based experiments.

Eichinger and Roth (1991) analyzed concept development in the elementary textbook series, Silver Burdett & Ginn science. They first analyzed the overall content organization by its scopes and sequences and then examined how particular topics were developed in and across the second-, third-, and fifth-grade texts. In the analysis of content organization, they found that the science curriculum was organized around topics in a science discipline such as Life Science and Physical Science. Generally, major topics were repeated in successive or alternate years.

The analysis of the texts by university curriculum experts and elementary teachers in Eichinger and Roth's study revealed problems in concept development. The textbook series lacked adequate connections among concepts. The text overemphasized memorization of isolated facts, especially at the upper grade levels and did not encourage students to apply concepts to different contexts. Another problem was the lack of attention paid to students' prior knowledge.

In the review of previous literature it is concluded that most of elementary science textbooks were not likely to help students develop connected and useful understandings of science concepts because the texts did not provide much support in linking ideas together, especially in linking science concepts with their prior knowledge and society.

Method

The elementary science textbook series (1994) selected in this study were used by all of the elementary schools in Taiwan except lab schools or classes experimenting new science curriculum. The textbooks were developed from Taiwan government based on standard science curriculum in 1974 and revised twice in 1985 and 1989.

A textbook review was conducted to examine how the three biological concepts of living things, animals, and plants were presented in the text from grades 1 to 4 in Taiwan. The textbook analysis had three major areas of concern: attributes of the concepts related to living things, animals, and plants, the development of the three biological concepts in the text and the pedagogical emphasis of the text. In addition, fourth graders' concepts of living things, animals, and plants, based on the Shiao's (1996) research findings, were compared with the concepts presented in the elementary science text.

Procedures for the Textbook Review

The procedure used in the textbook review is modified from Tull's (1990) method. The topics of the units related to the three biological concepts and attributes (e.g., "habitat" and "structure") of the related biological concepts covered in the first through fourth grade texts were documented. Attributes were categorized according to the 16 groups of attributes for living things (see table 1), which were developed by Shiao (1995) and modified from Carey's (1985) groups. Concept maps (Novak & Gowin, 1984) for each of the units related to the three concepts were drawn.

All questions, descriptive sentences for facts in science and directions for experiments, and diagrams in the units related to the three biological concepts found in the first through fourth grade texts were documented. Questions were also coded into two categories: fact (answers of questions are facts in science, not related to

experiments or activities in the text) and experiment (questions are raised due to doing experiments or activities).

For example, there are different kinds of statements in the unit of "Seed Germination". The statements "There are many kinds of seeds, and let's sort them." was coded into "experimental direction"; the statement "After seeds are soaked in the water, are seeds getting bigger and bigger?" was coded into the category, questions associated with experiments; The statement "After seeds sprout, seedlings grow gradually." was a fact in science. It is an descriptive sentence and coded into the category, "fact". Two charts are presented in this unit to measure and compare the growth of seeds after being soaked in water, They were coded into "diagram".

Analysis of the Textbook Data

A list of the attributes of the concepts related to living things, animals, and plants addressed in the text from the first to the fourth grade was analyzed in search of patterns of discussion common to the three related concepts.

The content organization of the text was analyzed through a diagram showing the sequential relationships of all topics of the units related to the three concepts from grades 1 to 4. Concept development in the texts, the textbook development of the three biological concepts from grades one to four, was analyzed through concept maps. The following aspects of the textbook were analyzed:

a Connections between concepts: Concept maps were used to evaluate connections between interrelated concepts.

b Levels of complexity: Concept maps were used to examine the number of hierarchical levels used in developing each concept.

c Repetition: Repetition of the concepts were documented.

The relative frequency of questions, facts, experimental directions, and diagrams in all units related to the three concepts from grades one to four was calculated to analyze the pedagogical emphasis of the text.

Students' three biological concepts were compared to those in the textbook. The comparison focused on the attributes that students used for the three concepts and attributes of the concepts presented in the textbooks..

Results and Discussions

The analysis of the elementary science textbooks in Taiwan from grades 1 to 4 resulted in description of three main aspects: the attributes of the related concepts of living things, animals, and plants, concept development of the three concepts in the text, and the pedagogical emphasis of the text. In addition, the comparison of children's concepts with the text is also discussed.

Attributes Related to the Three Concepts

The topics of all 15 units associated with the three concepts in the elementary science textbooks from grade one through four and the attributes related to the three concepts in the 15 units are summarized in Table 2. In the texts the commonly used attributes of the related concepts of living things, animals, and plants were: "habitat", "movement", "growth", "energy source", and "structure". Among them "structure", especially morphological structure (shape, color, size, or appendages) is the most frequently addressed attribute. The commonly used attributes of the three concepts differ slightly. The text discusses "structure", and "have life" more often for living things; "habitat", "how they move", "structure" and food more often for animals; and "growth", "structure", and "habitat" more often for plants.

All classification diagrams in the units are based on the proposed attributes, such as six legs ("structure"), eating plants and animals ("energy source"), and member of a group ("are animals or plants"). Four of the 15 units related to the three concepts include classification tasks. Three of them have classification diagrams. In the unit, "Aquarium" in grade 1, there are two similar hierarchical diagrams, one for

dividing things in an aquarium into two subgroups, living things and nonliving things, and another for dividing living things into animal and plant subgroups. The unit "Small Animals" in grade 2 presents the same kind of diagram to divide small animals into two subclasses, one with six legs and another without six legs.

Similarly, in the unit "Food Chain" a diagram with more hierarchical levels is provided. The first level classification involves dividing animals (spiders, caterpillars, cat, snakes, roosters, and rabbits) into two subgroups of eating or not eating animals. The subgroup, eating animals, is further divided into two groups by eating plants or not.

Children's attributes for the three concepts (Shiao, 1995) did not reflect many similarities to those presented in the textbooks. For many students, "movement" ("can move") was a more important trait of living things than "growth", and "have life", as emphasized in the text. "Movement" was used much more often as a critical feature of animals than other attributes. "Movement" ("cannot move"), "growth", "habitat" ("grow in soil) and "have life" were commonly used as defining attributes of plants, but not "structure".

Concept Development

Concept development in the text was analyzed with focus on content organization and connections, repetition, and complexity of the three concepts in the 15 units. Concept development was analyzed from the perspective of students' conceptual development.

Organization of the Three Concepts

The sequential relationships of the topics for 15 units related to the three concepts are shown in Figure 1, and the major concepts in each topic presented in Table 3. The data demonstrate that as students move from the first to fourth grade level, the biological concepts are developed from higher to lower hierarchical levels.

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The concepts of living and nonliving things are discussed at the beginning of first grade and the concept of living things is one of the earliest biological concepts introduced during elementary school years. More topics of animals or plants are provided later in the first and second grades. At third grade, more specific animals, such as earthworms, silkworms, and fish, and specific plants such as aquatic plants are presented.

According to children's concept development (Anglin, 1977; Callanan, 1985) and the fourth graders' three concepts (Shiao 1995), it might be proper for the science text to begin with basic level and familiar concepts like fish or birds, then introduce higher hierarchical level concepts such as animals and plants, and lastly, the superordinate level concept of living things. It appears that in school students are taught these concepts backward.

Connections to each other among the 15 topics related to the three concepts (see Figure 2-4) are rarely addressed in the text though they are mentioned in the teacher's guide. For instance, several topics are related to the animal concept: "Lovely Animals" in grade 1; "Small Animals" and "Common Animals" at grade 2; and "Earthworms", "Silkworms", and "Fish" in grade 3. In the unit of "Lovely Animals", examples of various kinds of animals: insects, mammals, birds, and reptiles are introduced; in "Small Animals", different types of animals such as insects and earthworms are introduced; and in "Common Animals", vertebrates such as mammals, birds, and fish are introduced. Earthworms, silkworms, and fish are not linked to any of the previous units. In the text the connections among all of the units related to the animal concept are not addressed at all.

Similarly, three units ("Common Living Things", "Pretty Flowers" and "Let's plant beans") related to plants explicitly discuss characteristics of flowers. The connections of the flower concept among the units are not addressed. Also, no connections are made between the concepts in the two units regarding seed

germination. One is "Seed Germination", and the other is "Let's Plant Beans". Apparently, students are expected to see and make these connections by themselves.

Connections Between Concepts

The concept maps (Figure 2- 4) of the 15 units showed gaps in the text between some interrelated concepts. In the unit "aquarium", the links of the shared attributes in a contrasting way between living things and nonliving things and between plants and animals are not explicitly presented. No questions or propositions concern similarities between animals and plants in the unit. The text of "Common Living Things" asks characteristics of animals and plants separately, but does not discuss the common attributes among plants and animals, and does not review the relationship where by living things subsume animals and plants. Thus animals and plant are not connected to living things and no links are made between plants and animals.

Also, in the unit of "Common Animals" at grade 2, the text introduces three kinds of commonly seen animals, mammals, birds, and fish. No connections, like having a backbone, were made among the three kinds of animals. The term "mammals" is not mentioned, although the characteristics of mammals are addressed. It would be proper to mention "mammal", which would make the concept and links to it more clear.

In addition, the relationship between the concepts of flowers and plants is not pointed out in the unit of "Pretty Flowers" in grade 2 though it is mentioned in the unit of "Common Living Things" in grade 1. The fragmented concepts may be one of the reasons why students did not have coherent views of the three concepts (Shiao, 1995). However, material in some of the 15 units is well presented, with connections between various levels in hierarchy. The unit "Silkworms" is one of them. At the beginning of the unit, the text reminds students of the life cycle of bean plants in a previous unit. The text attempts to tie the new life cycle of silkworms to students' prior knowledge.

Repetition of the Three Concepts

The content organization also indicates that the text is designed to provide students with repeated as well as regular exposure to the three concepts. For instance, students repeatedly investigated the concepts of plants, leaves, stems and roots in "Plant Body" in grade 2, "Aquatic Plants" in grade 3, and "Plant Transportation" in grade 4.

A number of examples and attributes for the three concepts are repeated within or across grades. The text repeated some examples of animals in related units. For example, fish are mentioned in four units in grades one and two as an example of a living thing and an animal. Similarly, the morphological structures of animals are repeatedly addressed generally or specifically with different animals.

However, some of the concepts lack repetitions in different contexts. The concept of living things is first introduced in the aquarium unit at first grade, and is the only content dealing with the distinction between living and nonliving things. In the unit, all living things in this unit are aquatic. No other unit discusses the difference between living and nonliving things again. This may mislead students to think that living things are things living in water (Shiao, 1995).

Though the concept of living things is repeated once in the unit of "Common Living Things" in grade 1, connections between living things and plants and animals are not made. The shared attributes between animals and plants are not discussed in that unit, either.

Levels of Complexity

The concept maps (Figures 2-4) revealed the complexity of the material presented in each of 15 units related to the three concepts. In grades 1 and 2 the maps included from three to four hierarchical levels except the unit of "Let's Plant Beans" which include nine levels. In grades 3 and 4, three to five levels are common, and several concepts have eight to ten levels. As the grades get higher, the maps become

more complex. Most of the hierarchical levels in the units are less than five. The textbook authors seem to make the relationships among the concepts in the text simple so that students can deal with them.

However, the unit "Aquarium" probably is very difficult for first graders to comprehend. The major concepts include four hierarchical levels. The highest level concept is "things" including living and nonliving things, which are at second level, and living things consist of animals and plants, which are at third level. Examples for aquatic animals and plants are at the lowest level. According to Inhelder and Piaget (1964), children have difficulty in developing the relationships between a class and its sub-classes or super-ordinate classes. The relationship with four levels is beyond first graders' comprehension.

Pedagogical Emphasis of Text

The text is very question-oriented. Sixty-one percent of the statements in the 15 units are questions, 15% of them are descriptive sentences for factual knowledge in science, 20% are experimental directions, and 3% are diagrams (see Table 3). Question oriented textbooks place emphasis on science as a way of thinking rather than a body of knowledge. It seems that textbook authors pay attention to students' prior knowledge of science concepts by asking many questions. But the text does not bridge the gaps between children's concepts and those of scientists.

The text develops biological concepts mainly by raising questions. Questions can motivate students to focus attention and thinking and promote learning. However, the answers of the questions, the major content of the text, are usually not presented in the text, but sometimes explicitly appeared in pictures. Lacking answers for the questions and adequate links between concepts it would not be possible for students to develop meaningful understanding of the three concepts without effective instruction.

Overall, 60% of statements are associated with experiments or activities (see Table 3). Experiments are mixed with content in the text and attempt to develop

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students' process skills and concept understanding at the same time. It seems that the text puts as much emphasis on process skills as on concepts. However, the experimental procedures usually are presented in the text and students have to follow them while doing an experiment. The experiments in the text are used to confirm scientific facts or to provide observations of the facts. Most of the scientific knowledge are not explicitly provided in the text.. The text lacks inquiry based experiments.

In most classification tasks, students are just asked to list members in each subgroup. They are not encouraged to develop their own schemes to classify things, living things, and animals. However, there is one unit, "Seed Germination", in which students can sort seeds in their own ways.

Many familiar examples and pictures of animals and plants are presented in the text. However, the text puts more emphasis on differences of examples or concepts rather than similarities. For example, "How are aquatic plants different in features?" is given in the unit "Aquatic Plants". This may cause students having difficulty to make links across examples in a group or related concepts and integrate the defining attributes of concepts.

Thorough understanding of science concepts means enabling students to apply the concepts in different contexts and does not mean memorizing isolated concepts or facts (Eichinger and Roth, 1991). Applications of the concepts related to living things, plants, and animals are given little coverage in the text. Human dependence on plants and animals is not explicitly discussed in the related units except in the unit "Food Chains", which gave some examples to explain how people relate to animals and plants.

Conclusions and Recommendations

The analysis of the science textbooks in Taiwan from grades 1 to 4 reveals problems in content organization, concept development, and pedagogical emphasis.

The organization of the three concepts is opposite to the trend of concept development. It is suggested that the text organize the three concepts from more specific concepts (e.g., fish and silkworms), to lower level and less general concepts (animal and plants), and then to a very high and more general level concept of living things.

Based on development of logical thinking in class inclusion, three or four levels of hierarchical relationships of the three concepts involved in the first grade unit "Aquarium" are beyond first graders' comprehension. Therefore, it is proper to address the concept of living things and hierarchical relationships with animals and plants at a later time in elementary school years.

Links among the three and related concepts within a unit or across units are not adequately made in the text. The text needs to provide enough information to allow connections between the three concepts.

The text presented science as a way of thinking and as a process, but needs to put more emphasis on application of concepts in different contexts and on inquiry based experiments. Besides, instead of following the presented schemes, the text requires to help students develop their own classification schemes in classification tasks.

In Taiwan science textbooks are the major, and often the only, source used by elementary teachers. Thus, the problems found in this study are essential o improving science curriculum and instruction.

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Table 1. Categories of Attributes for Living Things

Group	No.	Subgroup	Example
I Biologically irrelevant	1	Use	A crayon is not living because it is for drawing.
	2	Fact	A doll is not living because it is a toy.
	3	Existence	The sun is living because it is a natural phenomenon.
	4	Other reasons	A mushroom is living because an encyclopedia said that.
II Habitat	5	Habitat	The sun is not living because it is in the sky (not on earth).
III Anthropomorphic trait	6	Anthropomorphic trait	Living things have faces and wisdom.
IV Movement	7	Movement	A frog is living because it is can jump and swim.
	8	Autonomous movement	A doll is not living because it can not move by itself.
V Biological characteristics	9	Have life (viability)	A boy is living because he has life.
	10	Growth	A tree is living because it can grow.
	11	Reproduction	A bird is living because it gives birth by bird parents.
	12	Energy source	A river is not living because it can not eat.
	13	Breath	A seed is living because it breaths.
	14	Can respond	A butterfly is living because it has life, can move, and respond.
	15	Structure	A crayon is not living because it is made from chemical material.
	16	Member of a group	A bird is not living because it is an animal.

Note: It is adopted from Shiao (1996).

Table 2. Attributes related to the Concepts of Living Things, Animals, and Plants in the Science Textbooks in Taiwan From Grades One Through Four

Grade	Unit name	Major concepts	Attributes related to major concepts
1	aquarium	living things, nonliving things, animals, plants	
1	lovely animals	animals	habitat, food, structure (body)
1	seeds geminated	seeds	growth, structure (color, size, shape)
1	common living things	living things, animals, plants, flowers, leaves	structure (color, size, shape)
2	small animals	animals	habitat, movement, structure (shape, legs), behaviors
2	plants' body	plants, roots, stems, leaves	growth, structure (shape)
2	common animals	animals, birds, fish	habitat, movement, food, structure (fur, fin)
2	pretty flowers	flowers, petals, stamen, pistil	habitat, structure (shape, color)
2	let's plant beans	seeds, flowers, fruit	growth, structure (shape)
3	aquatic plants	aquatic plants, roots, stems, leaves	habitat, structure (shape)
3	earthworms	earthworms	habitat, movement, structure (shape)
3	silkworms	silkworms	habitat, growth (life cycle), growth (dormancy), structure (shape)
3	fish	fish	habitat, movement, breath, structure (shape)
4	plant transpiration	roots, stems, leaves, plant transportation	growth
4	food chains	food chains, food webs, animals, plants	food

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Table 3. The Distributions of Statements in the Units Related to the Three Concepts in Elementary Science Textbooks in Taiwan

No.	Grade	Unit no.	Unit name	Questions			Descriptive statement				
				total	fact	exp.	fact	Dir.	Dia.	O	Total
1	1st fall	3	Aquarium	6	0	6	0	0	2	0	8
2		6	Lovely Animals	5	4	1	0	1	0	1	7
3	1st spring	5	Seeds Geminated	2	0	2	1	4	2	0	9
4		7	Common Living Things	2	2	0	0	3	0	0	5
5	2nd fall	2	Small Animals	7	2	5	2	1	1	0	11
6		3	Plants' Body	8	1	7	2	0	0	0	10
7		7	Common Animals	12	12	0	0	0	0	0	12
8	2nd spring	3	Pretty Flowers	6	0	6	0	1	0	0	7
9		4	Let's Plant Beans	7	0	7	1	1	0	0	9
10	3rd fall	2	Aquatic Plants	12	4	8	0	1	0	0	13
11		4	Earthworms	11	2	9	0	6	0	0	17
12	3rd spring	2	Silkworms	16	2	14	6	0	0	0	22
13		4	Fish	12	2	10	3	1	0	0	16
14	4th fall	3	Plant Transpiration	7	0	7	3	20	0	0	30
15		7	Food Chains	11	11	0	13	1	2	0	27
			total	124	42	82	31	40	7	1	203
			%	61%	21%	40%	15%	20%	3%	0%	100%

Exp. - experiment. Dir.-directions for experiment, Dia.-diagram; O-others

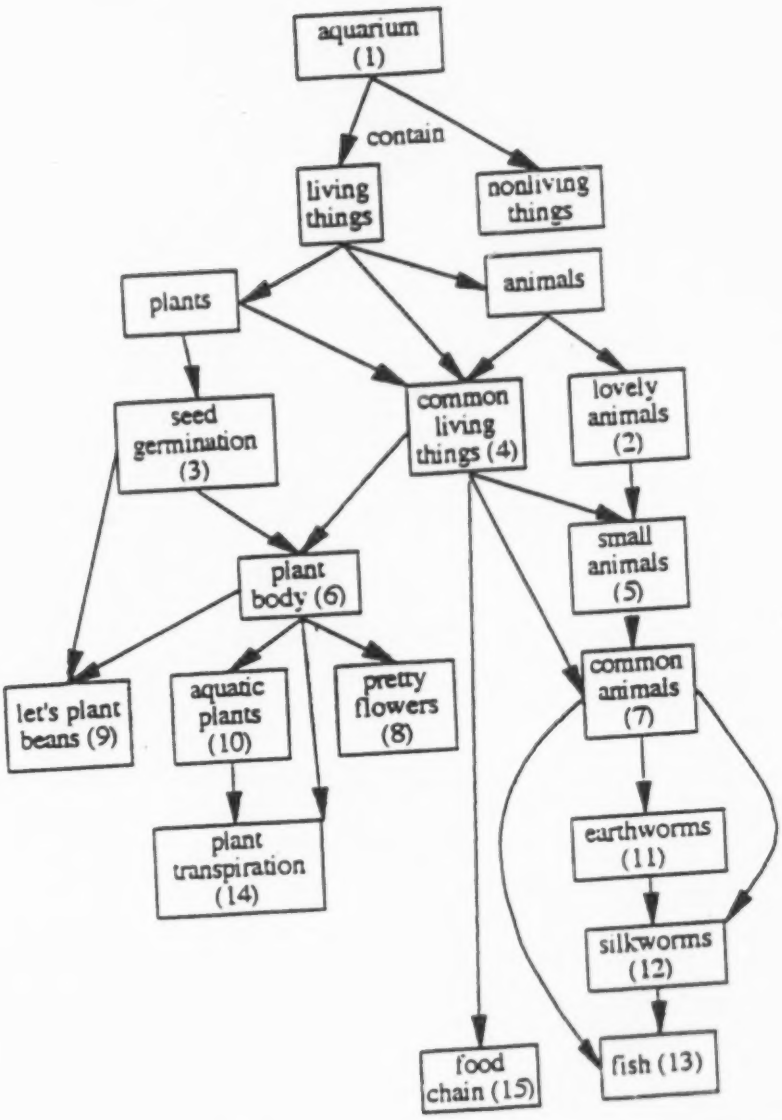

Figure 1. Development of the concepts of living things, animals, and plants in the elementary science textbooks in Taiwan from grades one to four.

Note: Numbers mean the sequence of units related to the three concepts.

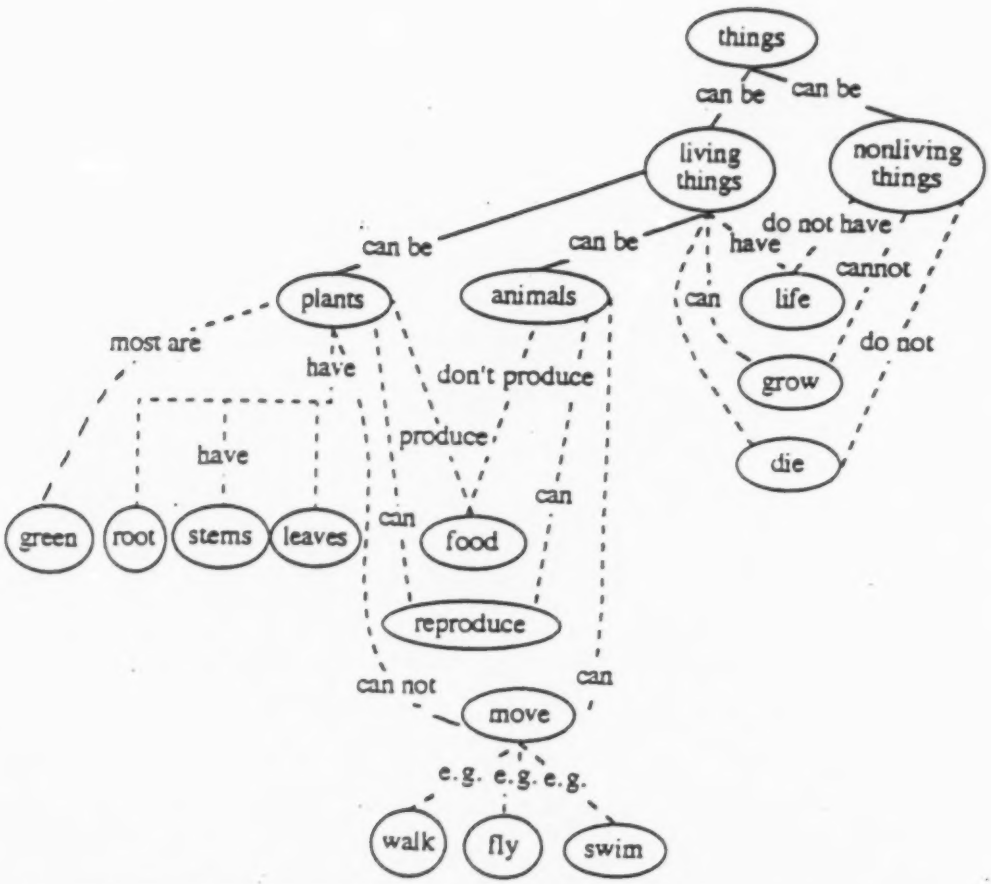

Figure 2. First Spring Unit 3 Aquarium

Note: Dashed lines mean that concepts are not explicitly addressed in the text, but in the teacher's guide.

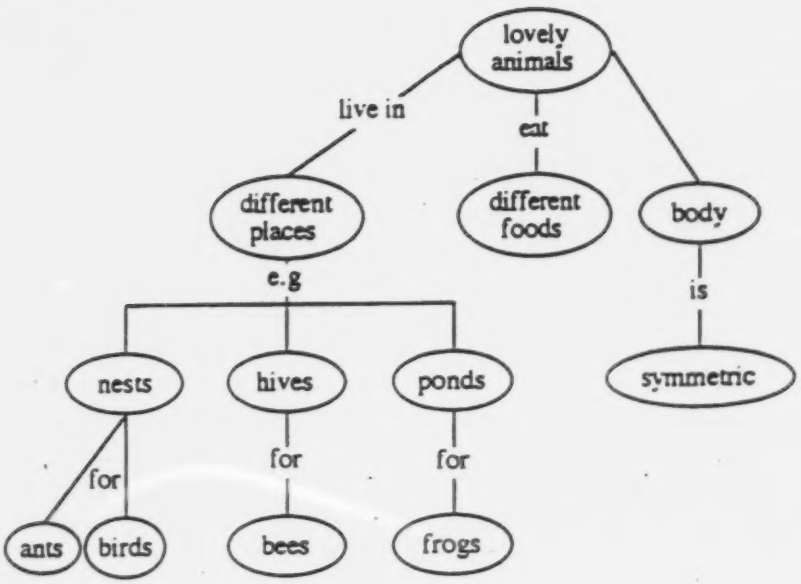

Figure 3. First Fall Unit 6 Lovely Animals

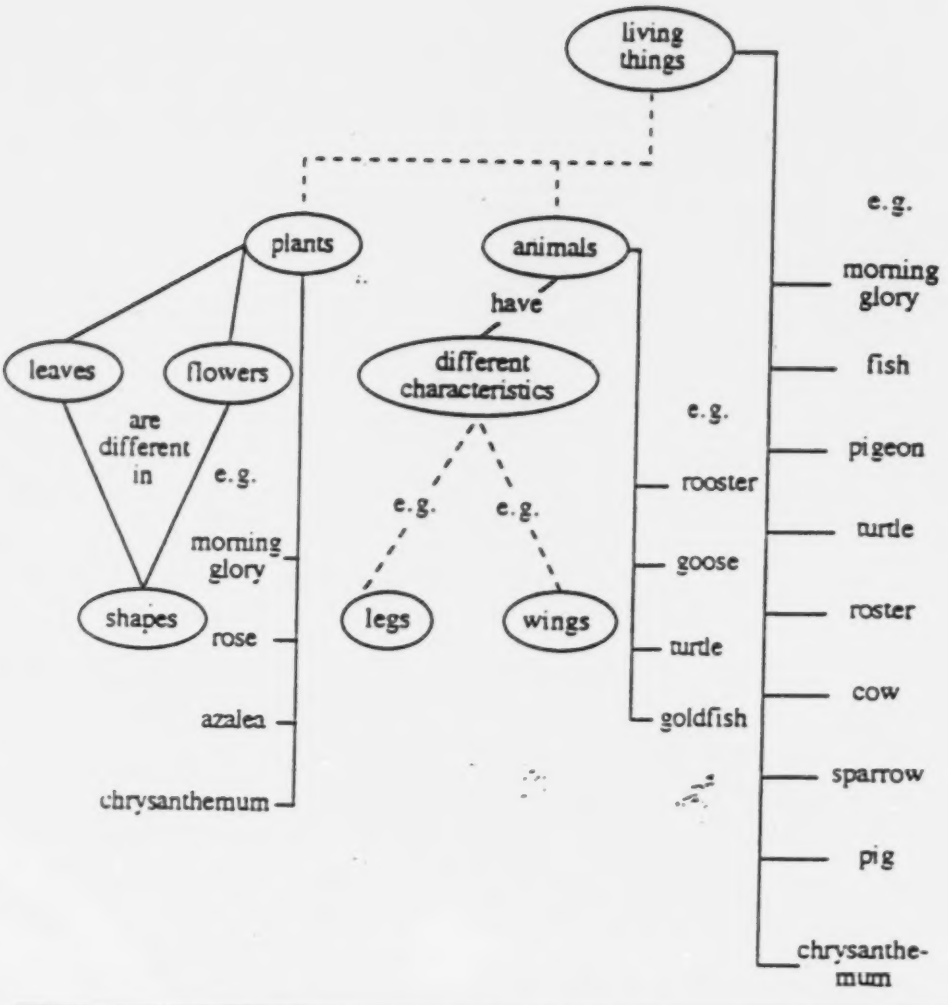

Figure 4. 1st Spring Unit 7 Common Living Things

Note: Dashed lines mean that links are not described in the text.

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